Digital Mobile Radio

- This is a DMR!

ZORCH!

Has this ever happened to YOU?...

WHEN….

- At 3:16PM on Saturday October 22, 2016 something happened to your TV reception…..

The Needham Tower

OFF AIR!

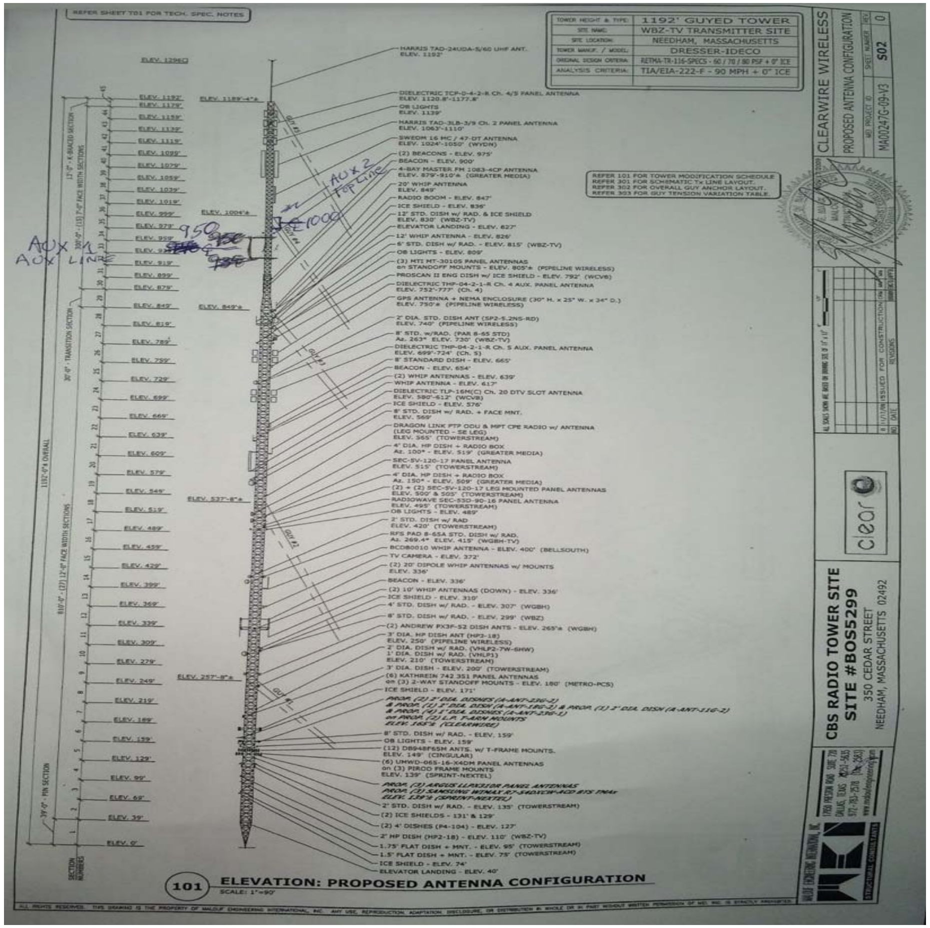
- WBZ-TV, WSBK-TV, WCVB-TV, and WGBX-TV left the air for a very simple, but expensive reason. WGBH-TV stayed on the air.
- Our remote controls told us the transmitters were not on the air, so an engineer from each station drove out to the Needham transmitter site to try to get things going again. I was one of them.

First Discovery

- We all found the reason our transmitters would not go back on the air.
- High SWR (VSWR)
- Have you had this problem? How much did it cost to fix??

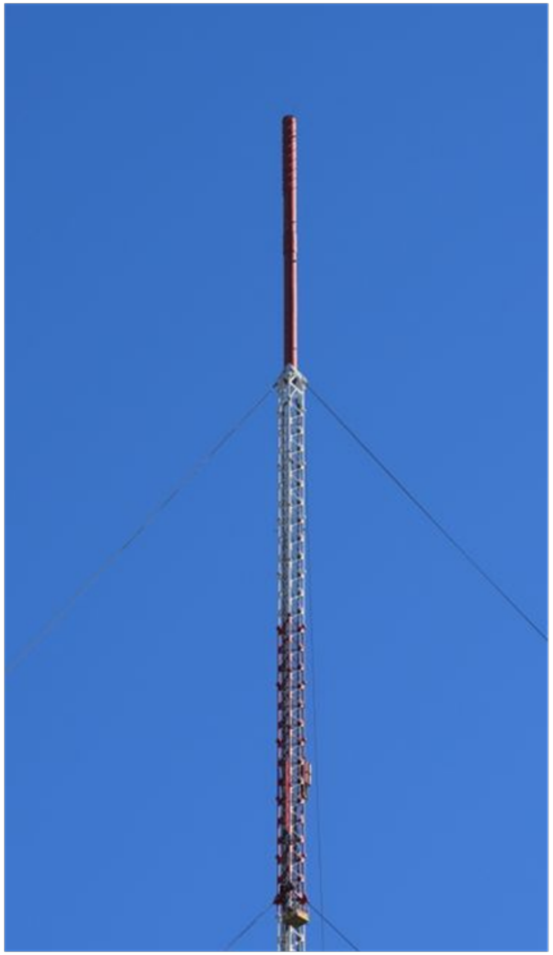
The tower is a complex system

- 1,250 feet full of antennas



REFER SHEET T01 FOR TECH. SPEC. NOTES
ELEV. 1296'
ELEV. 1192'
ELEV. 1179'
ELEV. 1159'
ELEV. 1139'
ELEV. 1119'
ELEV. 1099'
ELEV. 1079'
ELEV. 1059'
ELEV. 1039'
ELEV. 1019'
ELEV. 999'
ELEV. 979'
ELEV. 959'
ELEV. 919'
ELEV. 899'
ELEV. 879'
ELEV. 849'
ELEV. 819'
ELEV. 789'
ELEV. 759'
ELEV. 729'
ELEV. 699'
ELEV. 669'
ELEV. 639'
ELEV. 609'
ELEV. 579'
ELEV. 549'
ELEV. 519'
ELEV. 489'
ELEV. 459'
ELEV. 429'
ELEV. 399'
ELEV. 369'
ELEV. 339'
ELEV. 309'
ELEV. 279'
ELEV. 249'
ELEV. 219'
ELEV. 189'
ELEV. 159'
ELEV. 129'
ELEV. 99'
ELEV. 69'
ELEV. 39'
ELEV. 0'
ELEV. 1189'-4"±
ELEV. 1004'±
ELEV. 849'±
ELEV. 537'-8"±
ELEV. 257'-8"±
1192'-0" OVERALL
SECTION NUMBERS
AUX 1
AUX LINE
950
950
AUX 2
Pop Line
E1000
HARRIS TAD-24UDA-5/60 UHF ANT. ELEV. 1192'
DIELECTRIC TCP-0-4-2-R Ch. 4/5 PANEL ANTENNA ELEV. 1120.8'-1177.8'
OB LIGHTS ELEV. 1139'
HARRIS TAD-3LB-3/9 Ch. 2 PANEL ANTENNA ELEV. 1063'-1110'
SWEOM 16 MC / 47-DT ANTENNA ELEV. 1024'-1050' (WYDN)
(2) BEACONS - ELEV. 975'
BEACON - ELEV. 900'
4-BAY MASTER FM 1083-4CP ANTENNA ELEV. 879'-910'± (GREATER MEDIA)
20' WHIP ANTENNA ELEV. 849'
RADIO BOOM - ELEV. 847'
ICE SHIELD - ELEV. 836'
12' STD. DISH w/ RAD. & ICE SHIELD ELEV. 830' (WBZ-TV)
ELEVATOR LANDING - ELEV. 827'
12' WHIP ANTENNA - ELEV. 826'
6' STD. DISH w/ RAD. - ELEV. 815' (WBZ-TV)
OB LIGHTS - ELEV. 809'
(3) MTI MT-30105 PANEL ANTENNAS on STANDOFF MOUNTS - ELEV. 805'± (PIPELINE WIRELESS)
PROSCAN II ENG DISH w/ ICE SHIELD - ELEV. 792' (WCVB)
DIELECTRIC THP-04-2-1-R Ch. 4 AUX. PANEL ANTENNA ELEV. 752'-777' (Ch. 4)
GPS ANTENNA + NEMA ENCLOSURE (30" H. x 25" W. x 34" D.) ELEV. 750'± (PIPELINE WIRELESS)
2' DIA. STD. DISH ANT (SP2-5.2NS-RD) ELEV. 740' (PIPELINE WIRELESS)
8' STD. w/RAD. (PAR 8-65 STD) Az. 263° ELEV. 730' (WBZ-TV)
DIELECTRIC THP-04-2-1-R Ch. 5 AUX. PANEL ANTENNA ELEV. 699'-724' (Ch. 5)
8' STANDARD DISH - ELEV. 665'
BEACON - ELEV. 654'
(2) WHIP ANTENNAS - ELEV. 639'
WHIP ANTENNA - ELEV. 617'
DIELECTRIC TLP-16M(C) Ch. 20 DTV SLOT ANTENNA ELEV. 580'-612' (WCVB)
ICE SHIELD - ELEV. 576'
8' STD. DISH w/ RAD. + FACE MNT. ELEV. 569'
DRAGON LINK PTP ODU & MPT CPE RADIO w/ ANTENNA (LEG MOUNTED - SE LEG) ELEV. 565' (TOWERSTREAM)
4' DIA. HP DISH + RADIO BOX Az. 100° - ELEV. 519' (GREATER MEDIA)
SEC-5V-120-17 PANEL ANTENNA ELEV. 515' (TOWERSTREAM)
4' DIA. HP DISH + RADIO BOX Az. 150° - ELEV. 509' (GREATER MEDIA)
(2) + (2) SEC-5V-120-17 LEG MOUNTED PANEL ANTENNAS ELEV. 500' & 505' (TOWERSTREAM)
RADIOWAVE SEC-530-90-16 PANEL ANTENNA ELEV. 495' (TOWERSTREAM)
OB LIGHTS - ELEV. 489'
2' STD. DISH w/ RAD ELEV. 420' (TOWERSTREAM)
RFS PAD 8-65A STD. DISH w/ RAD. Az. 269.4° ELEV. 415' (WGBH-TV)
BCD80010 WHIP ANTENNA - ELEV. 400' (BELLSOUTH)
TV CAMERA - ELEV. 372'
(2) 20' DIPOLE WHIP ANTENNAS w/ MOUNTS ELEV. 336'
BEACON - ELEV. 336'
(2) 10' WHIP ANTENNAS (DOWN) - ELEV. 336'
ICE SHIELD - ELEV. 310'
4' STD. DISH w/ RAD. - ELEV. 307' (WGBH)
8' STD. DISH w/ RAD. - ELEV. 299' (WBZ)
(2) ANDREW PX3F-52 DISH ANTS - ELEV. 265'± (WGBH)
3' DIA. HP DISH ANT (HP3-18) ELEV. 250' (PIPELINE WIRELESS)
2' DIA. DISH w/ RAD. (VHLP2-7W-6HW) 1' DIA. DISH w/ RAD. (VHLP1) ELEV. 210' (TOWERSTREAM)
3' DIA. DISH - ELEV. 200' (TOWERSTREAM)
(6) KATHREIN 742 351 PANEL ANTENNAS on (3) 2-WAY STANDOFF MOUNTS - ELEV. 180' (METRO-PCS)
ICE SHIELD - ELEV. 171'
PROP. (2) 2' DIA. DISHES (A-ANT-23G-2) & PROP. (1) 2' DIA. DISH (A-ANT-18G-2) & PROP. (1) 2' DIA. DISH (A-ANT-11G-2) & PROP. (4) 1' DIA. DISHES (A-ANT-23G-1) on PROP. (2) L.P. T-ARM MOUNTS ELEV. 165'± (CLEARWIRE)
8' STD. DISH w/ RAD. - ELEV. 159'
OB LIGHTS - ELEV. 159'
(12) DB948F65M ANTS. w/ T-FRAME MOUNTS. ELEV. 149' (CINGULAR)
(6) UMWD-06516-X4DM PANEL ANTENNAS on (3) PIROD FRAME MOUNTS ELEV. 139' (SPRINT-NEXTEL)
PROP. (3) ARGUS LLPX310R PANEL ANTENNAS PROP. (3) SAMSUNG WIMAX RF-5400XCW-ACD BTS TRAx ELEV. 139'± (SPRINT-NEXTEL)
2' STD. DISH w/ RAD. - ELEV. 135' (TOWERSTREAM)
(2) ICE SHIELDS - 131' & 129'
(2) 4' DISHES (P4-104) - ELEV. 127'
2' HP DISH (HP2-18) - ELEV. 110' (WBZ-TV)
1.75' FLAT DISH + MNT. - ELEV. 95' (TOWERSTREAM)
1.5' FLAT DISH + MNT. - ELEV. 75' (TOWERSTREAM)
ICE SHIELD - ELEV. 74'
ELEVATOR LANDING - ELEV. 40'
TOWER HEIGHT & TYPE: 1192' GUYED TOWER
SITE NAME: WBZ-TV TRANSMITTER SITE
SITE LOCATION: NEEDHAM, MASSACHUSETTS
TOWER MANUF. / MODEL: DRESSER-IDECO
ORIGINAL DESIGN CRITERIA: RETMA-TR-116-SPECS - 60 / 70 / 80 PSF + 0" ICE
ANALYSIS CRITERIA: TIA/EIA-222-F - 90 MPH + 0" ICE
REFER 101 FOR TOWER MODIFICATION SCHEDULE
REFER 301 FOR SCHEMATIC Tx LINE LAYOUT.
REFER 302 FOR OVERALL GUY ANCHOR LAYOUT.
REFER 303 FOR GUY TENSION VARIATION TABLE.
CLEARWIRE WIRELESS
PROPOSED ANTENNA CONFIGURATION
MEI PROJECT ID: MA00247G-09-V3
SHEET NUMBER: S02
REV: 0
0 11/17/08 ISSUED FOR CONSTRUCTION
NO. DATE REVISIONS
clear
CBS RADIO TOWER SITE
SITE #BOS5299
350 CEDAR STREET
NEEDHAM, MASSACHUSETTS 02492
MALOUF ENGINEERING INTERNATIONAL, INC.
STRUCTURAL CONSULTANTS
101 ELEVATION: PROPOSED ANTENNA CONFIGURATION
SCALE: 1"=90'
ALL RIGHTS RESERVED. THIS DRAWING IS THE PROPERTY OF MALOUF ENGINEERING INTERNATIONAL, INC. ANY USE, REPRODUCTION, ADAPTATION, DISCLOSURE, OR DISTRIBUTION IN WHOLE OR IN PART WITHOUT WRITTEN PERMISSION OF MEI, INC. IS STRICTLY PROHIBITED.

Top antennas



WGBH Transmitter

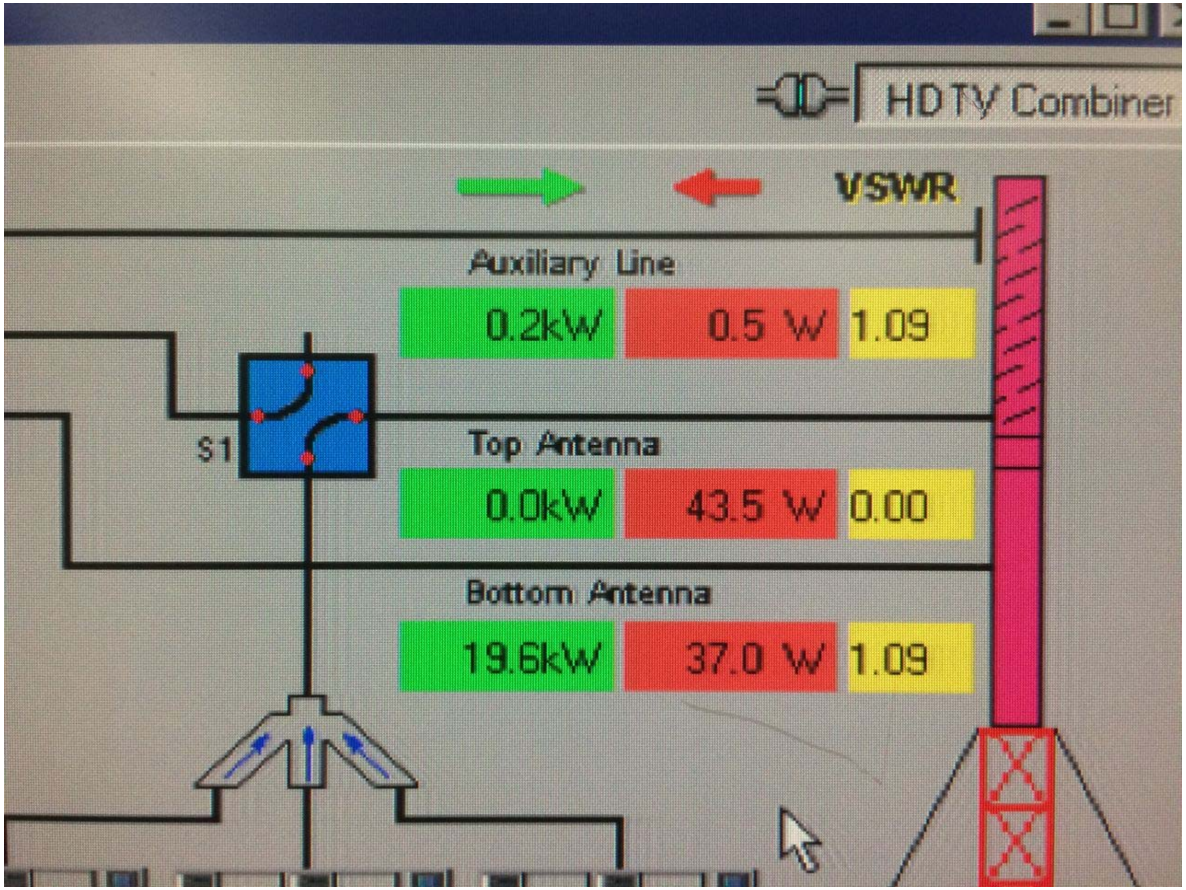
WGBX Transmitter

WCVB Transmitter

Scruffy the RF guard dog!

Top Antenna has no power

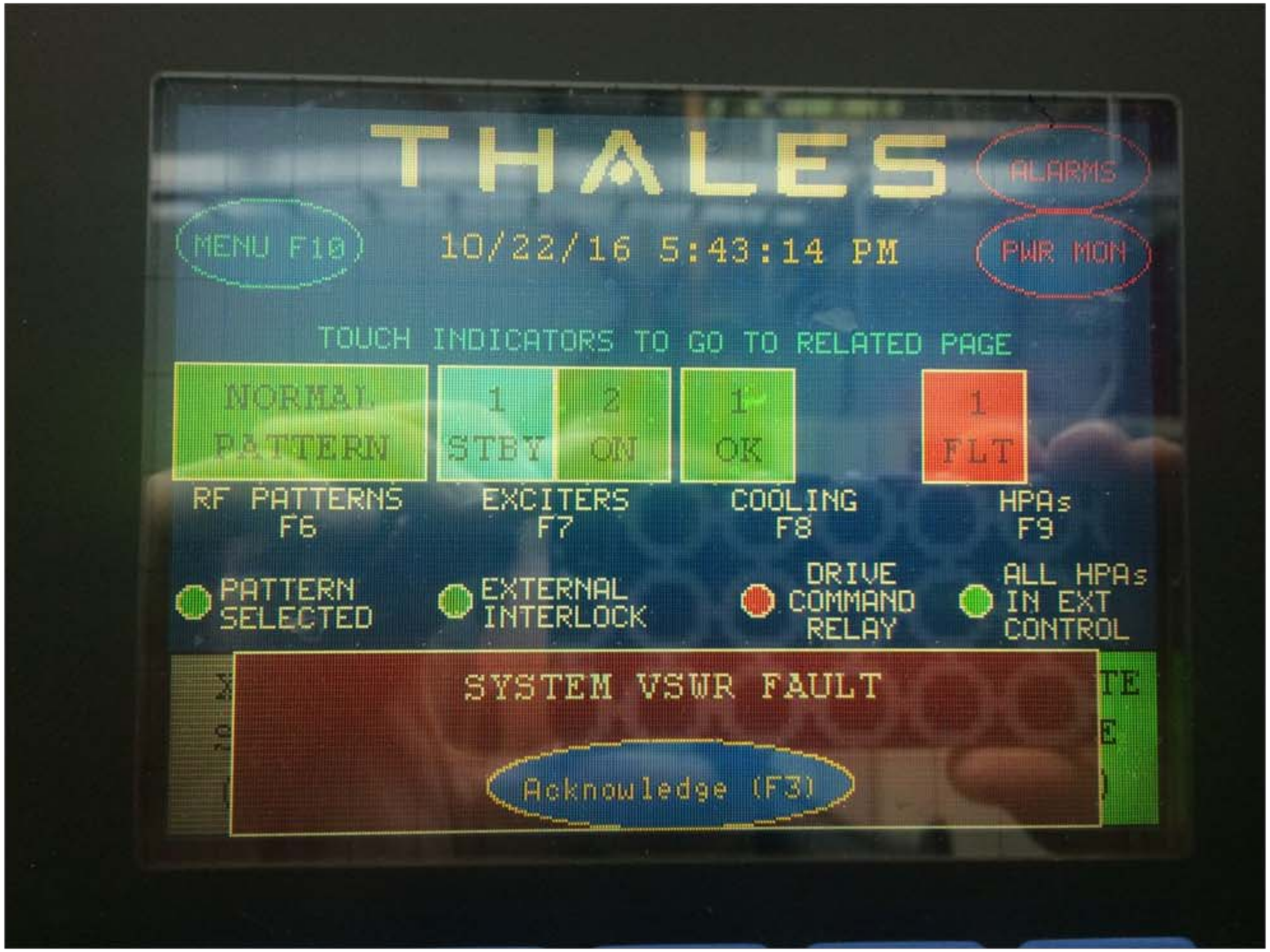
- See middle green section



HDTV Combiner

			VSWR
Auxiliary Line	0.2kW	0.5 W	1.09
Top Antenna	0.0kW	43.5 W	0.00
Bottom Antenna	19.6kW	37.0 W	1.09

Duh, what is wrong??



10/22/16 5:43:14 PM

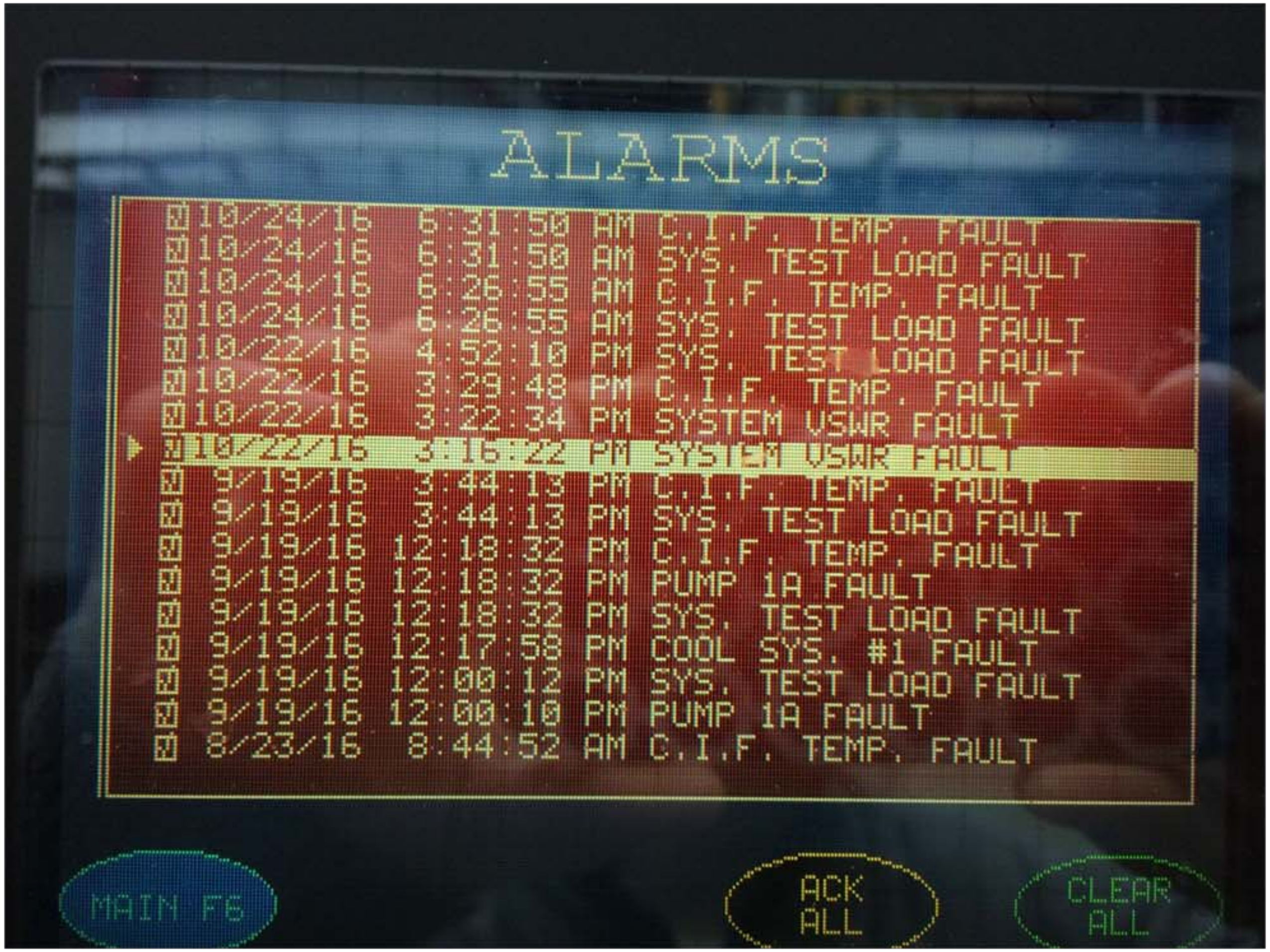
TOUCH INDICATORS TO GO TO RELATED PAGE

RF PATTERNS F6	EXCITERS F7		COOLING F8	HPAs F9
NORMAL PATTERN	1 STBY	2 ON	1 OK	1 FLT

● PATTERN SELECTED
● EXTERNAL INTERLOCK
● DRIVE COMMAND RELAY
● ALL HPAs IN EXT CONTROL

SYSTEM VSWR FAULT

The evidence is logged



```
 ☑10/24/16   6:31:50 AM C.I.F. TEMP. FAULT
 ☑10/24/16   6:31:50 AM SYS. TEST LOAD FAULT
 ☑10/24/16   6:26:55 AM C.I.F. TEMP. FAULT
 ☑10/24/16   6:26:55 AM SYS. TEST LOAD FAULT
 ☑10/22/16   4:52:10 PM SYS. TEST LOAD FAULT
 ☑10/22/16   3:29:48 PM C.I.F. TEMP. FAULT
 ☑10/22/16   3:22:34 PM SYSTEM VSWR FAULT
▶☑10/22/16   3:16:22 PM SYSTEM VSWR FAULT
 ☑ 9/19/16   3:44:13 PM C.I.F. TEMP. FAULT
 ☑ 9/19/16   3:44:13 PM SYS. TEST LOAD FAULT
 ☑ 9/19/16  12:18:32 PM C.I.F. TEMP. FAULT
 ☑ 9/19/16  12:18:32 PM PUMP 1A FAULT
 ☑ 9/19/16  12:18:32 PM SYS. TEST LOAD FAULT
 ☑ 9/19/16  12:17:58 PM COOL SYS. #1 FAULT
 ☑ 9/19/16  12:00:12 PM SYS. TEST LOAD FAULT
 ☑ 9/19/16  12:00:10 PM PUMP 1A FAULT
 ☑ 8/23/16   8:44:52 AM C.I.F. TEMP. FAULT
```

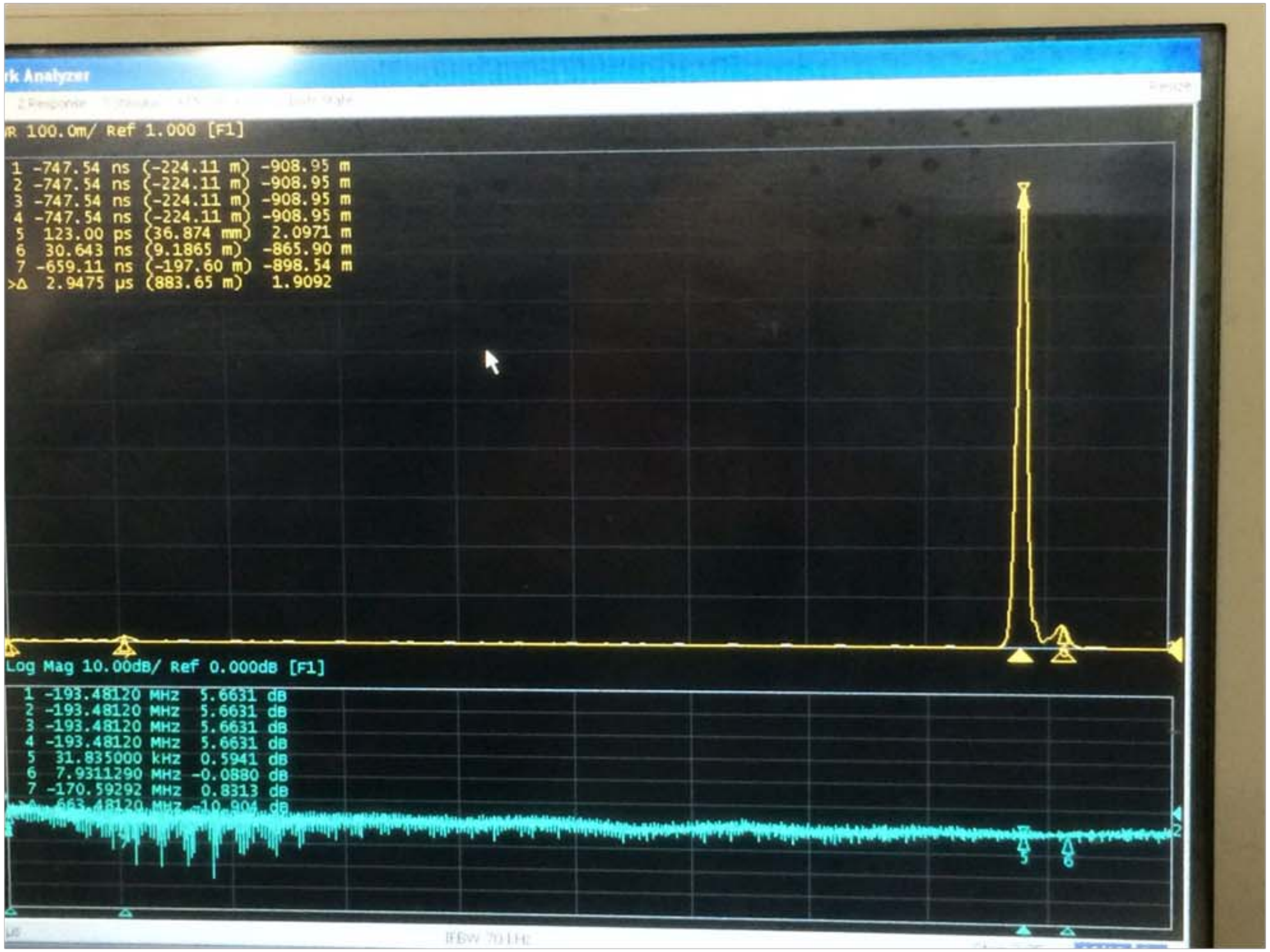
Recovery?

- WCVB had a small side antenna, and they went on that at low power.
- The rest of us....

A day later..

- An RF engineer arrived from Canada and tested the top antenna system with a signal analyzer in TDR mode.

Open Feedline at the top!



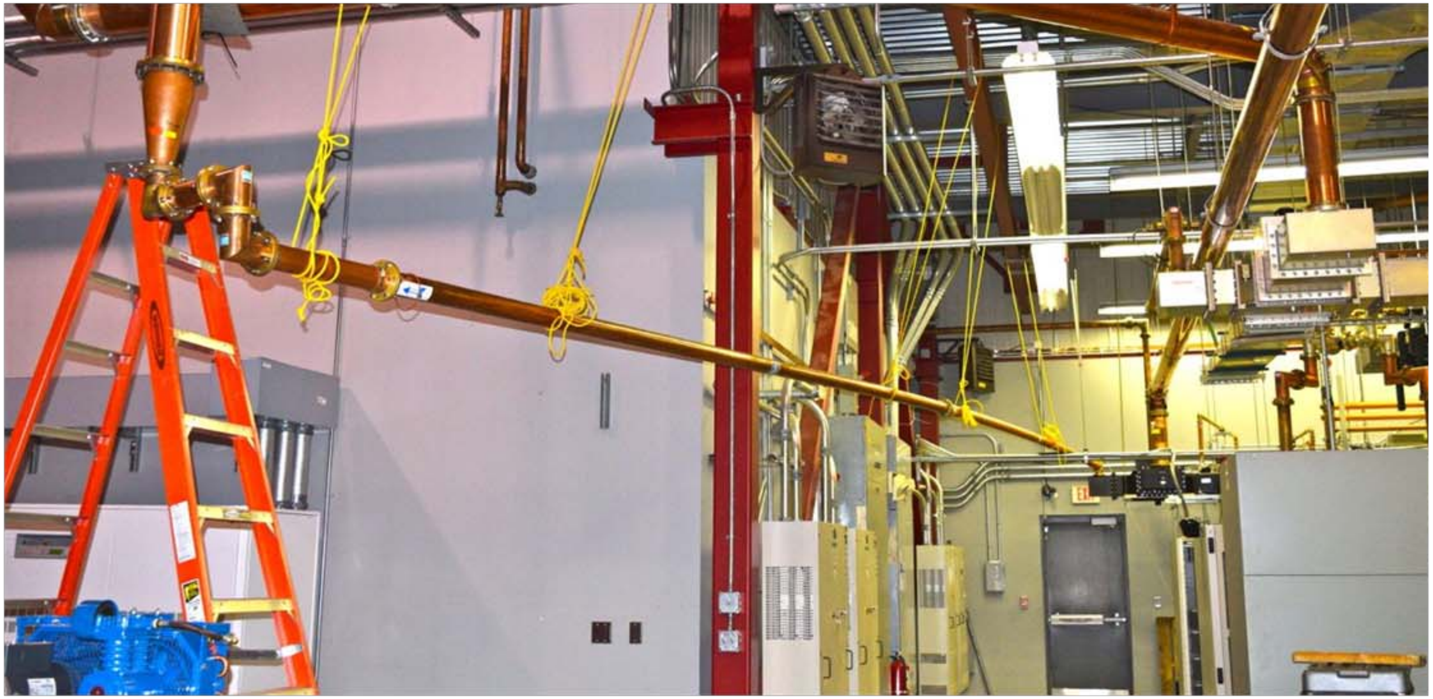
```
R 100.0m/ Ref 1.000 [F1]
 1 -747.54 ns (-224.11 m) -908.95 m
 2 -747.54 ns (-224.11 m) -908.95 m
 3 -747.54 ns (-224.11 m) -908.95 m
 4 -747.54 ns (-224.11 m) -908.95 m
 5  123.00 ps (36.874 mm)  2.0971 m
 6  30.643 ns (9.1865 m)  -865.90 m
 7 -659.11 ns (-197.60 m) -898.54 m
>Δ  2.9475 µs (883.65 m)   1.9092
```

```
Log Mag 10.00dB/ Ref 0.000dB [F1]
 1 -193.48120 MHz  5.6631 dB
 2 -193.48120 MHz  5.6631 dB
 3 -193.48120 MHz  5.6631 dB
 4 -193.48120 MHz  5.6631 dB
 5  31.835000 kHz  0.5941 dB
 6  7.9311290 MHz -0.0880 dB
 7 -170.59292 MHz  0.8313 dB
>Δ  663.48120 MHz -10.904 dB
```

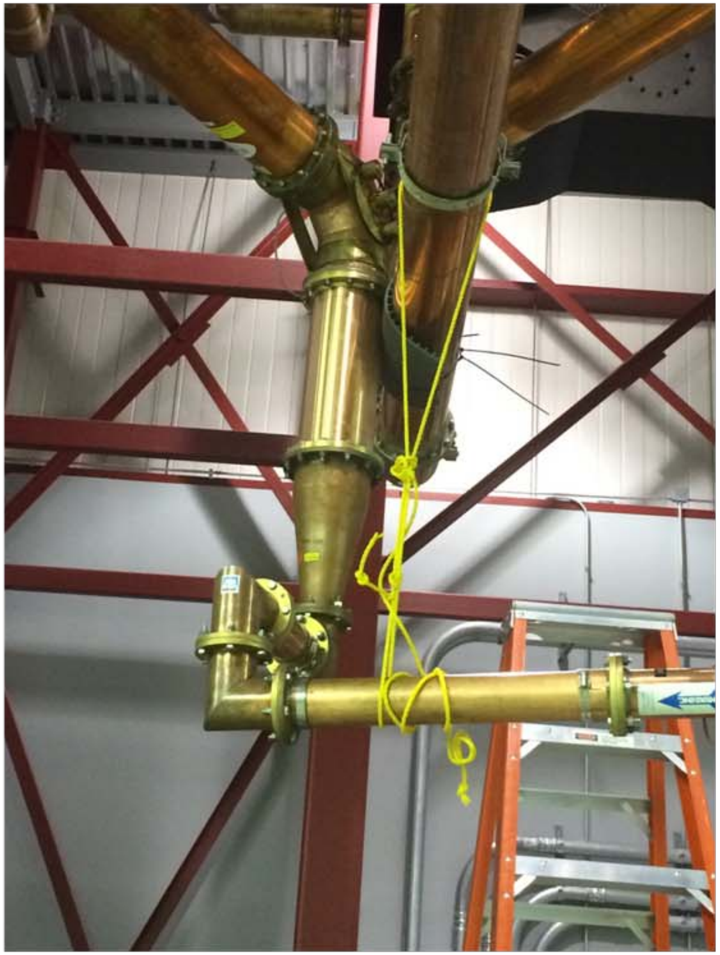
What to Do?

- Put WGBH on WCVB’s side antenna, move all top users on to the bottom antenna.
- But we need temporary antennas so we can investigate further and get better coverage than the WCVB side antenna.

Temporary 3” line



An adapter was needed

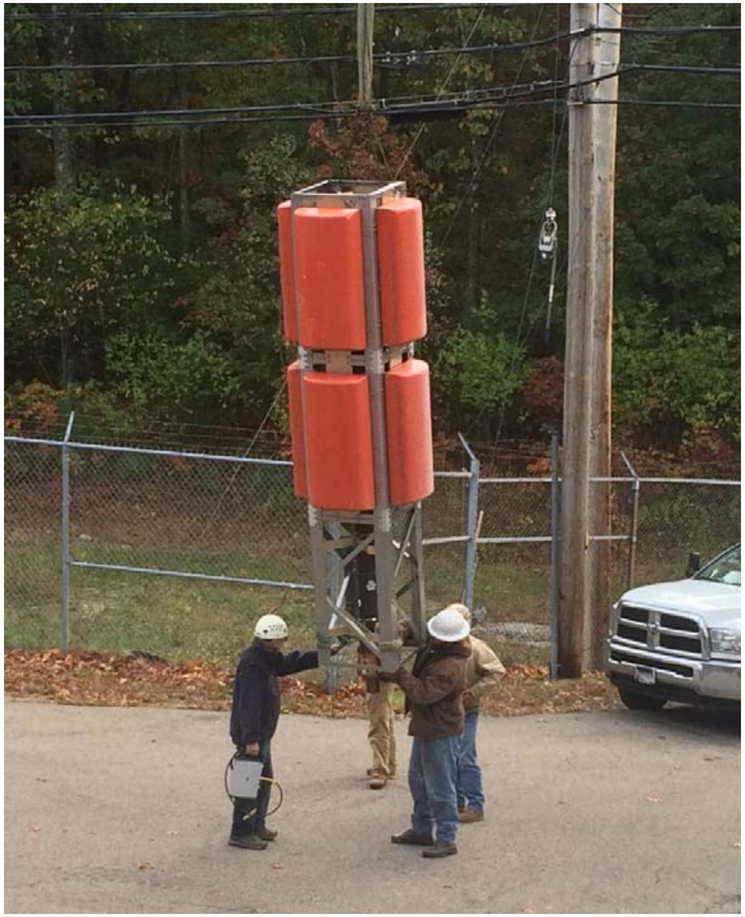


We used WCVB’s side antenna

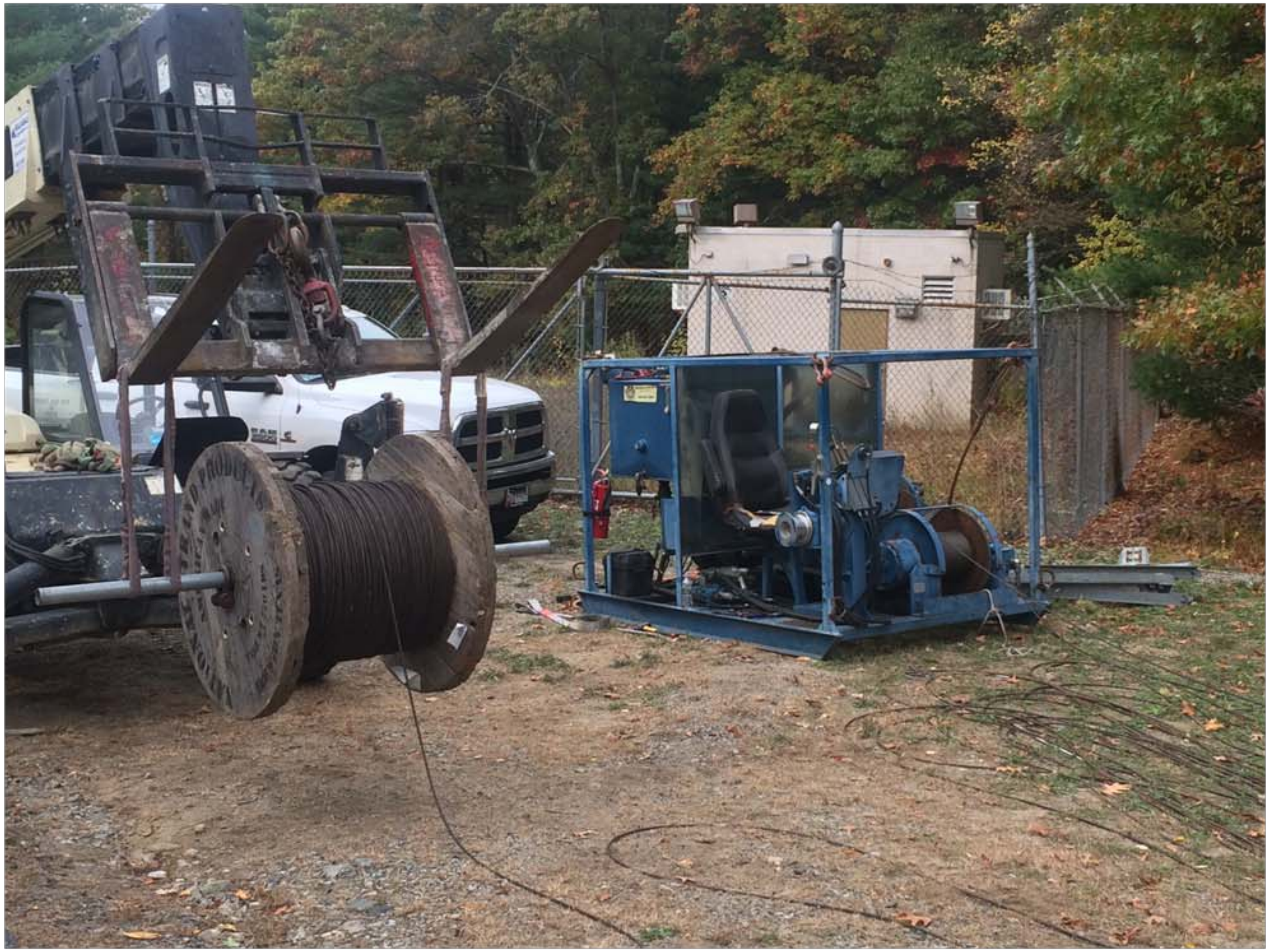
- Temporary line added to get the output of WGBH over to WCVB’s antenna
- WGBH had to run low power for a day or two until temporary antennas were delivered and installed.
- WBZ, WCVB, WSBK WGBX went on the lower antenna at full power

Temporary antennae arrived

- Being checked for impedance and bandwidth.



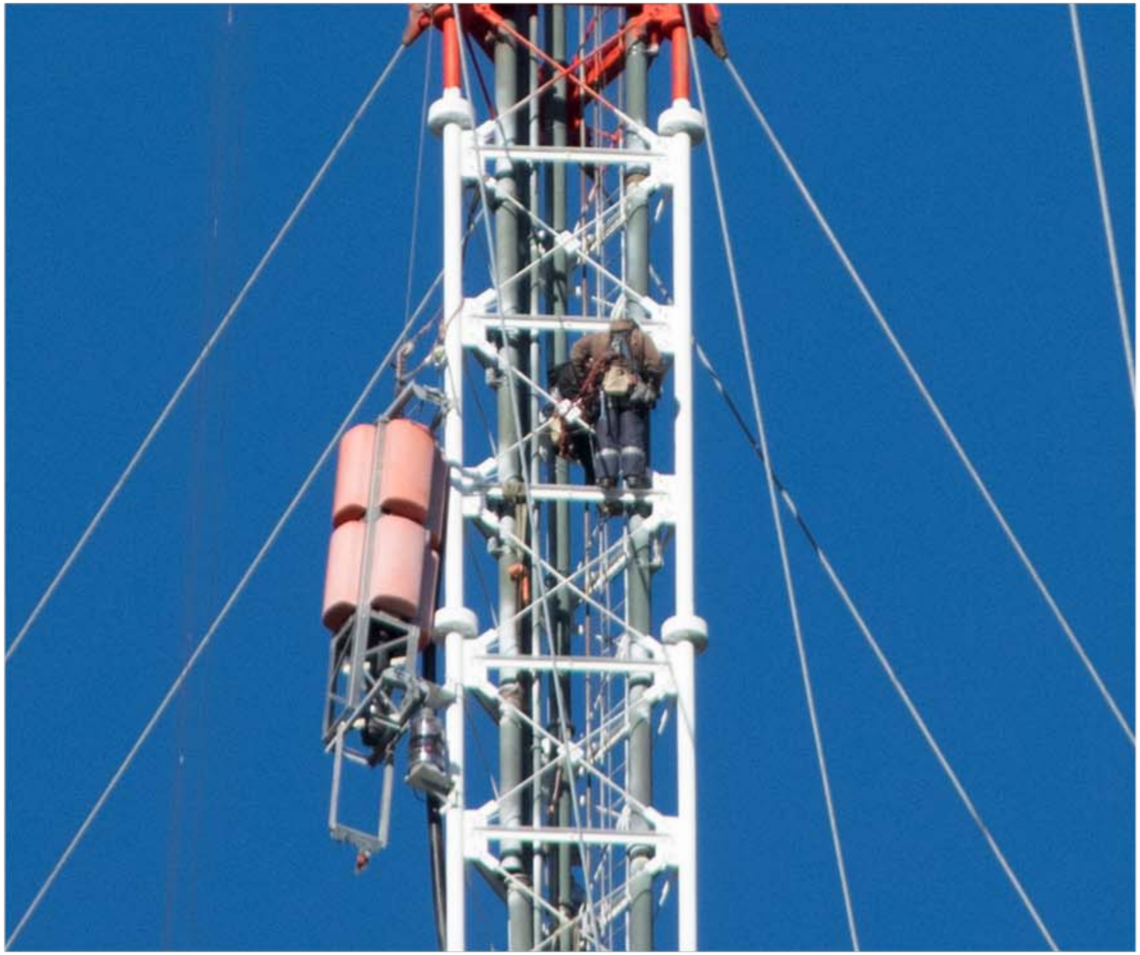
A winch with steel cable was used



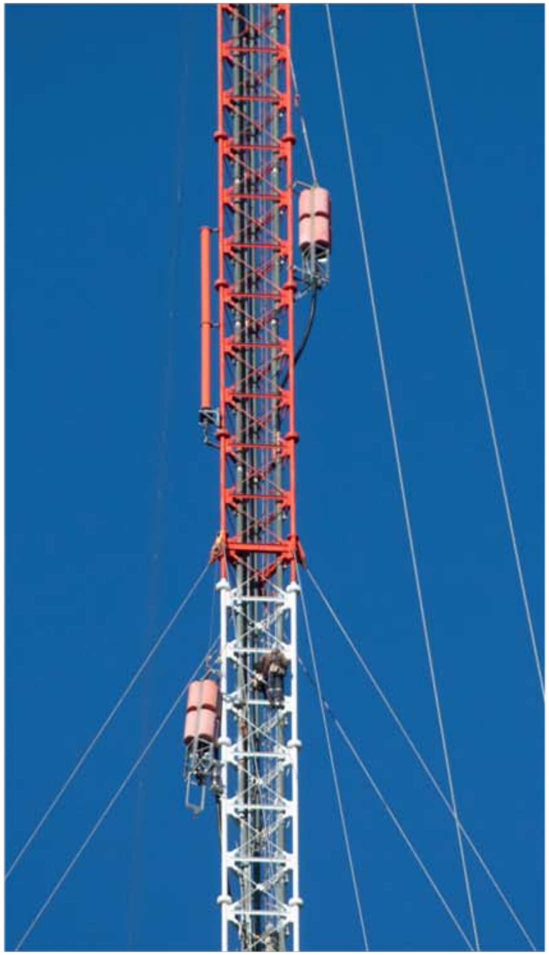
First antenna going up!

And up…

And installed



Two temporary antennas at about 1000’

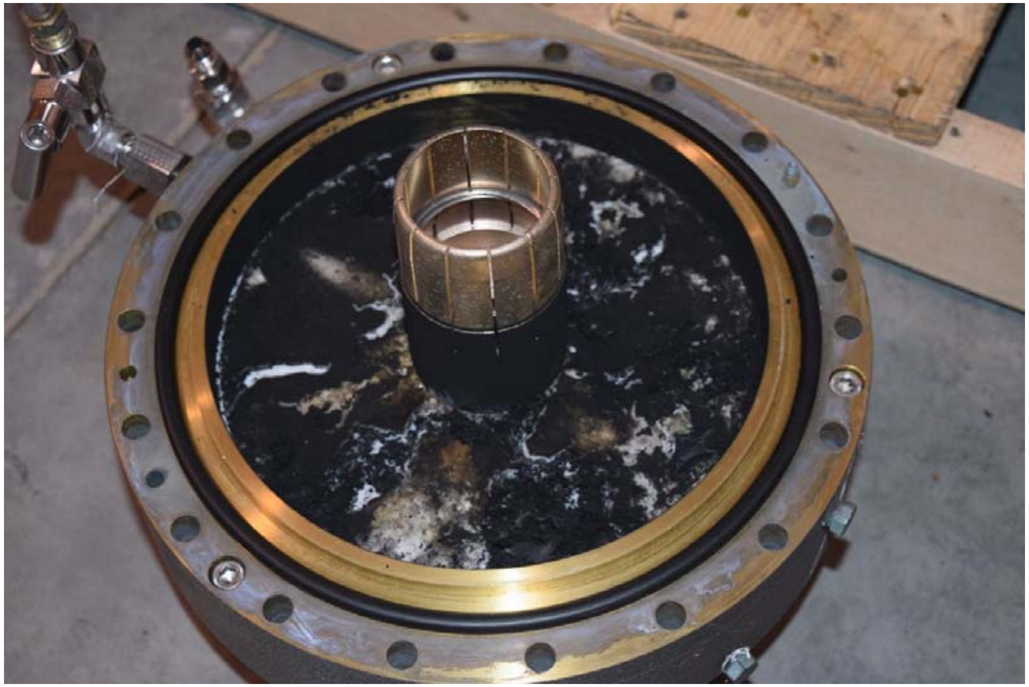


Temporary antennae were tested

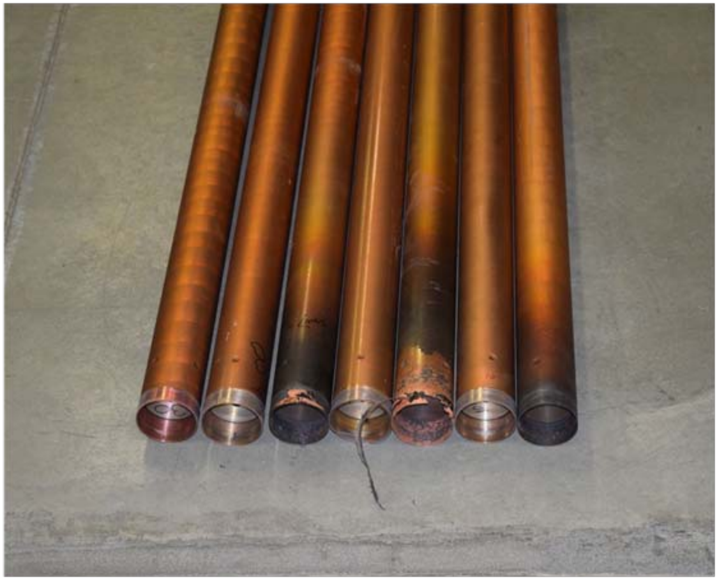
Then WGBH fed a temporary antenna

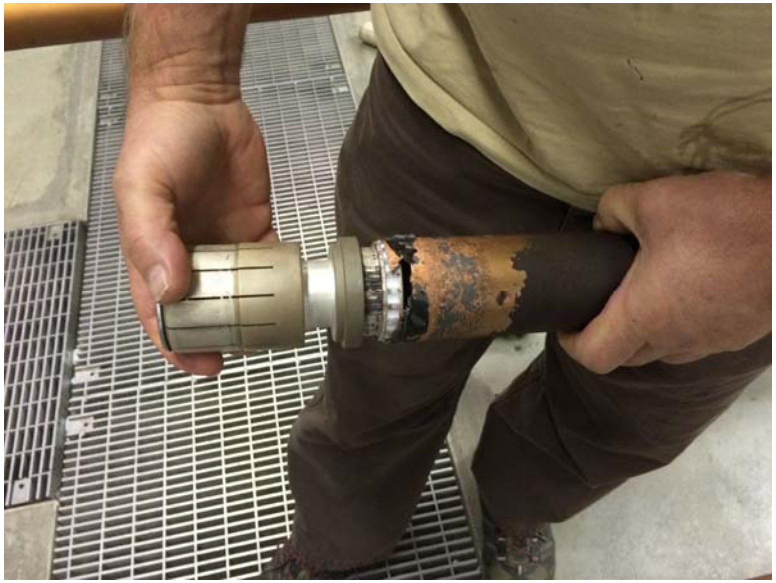
Then the top feed-line was inspected

- At the top of the tower, below the antenna a “gas barrier” divider was found to have extensive arcing on the insulator.



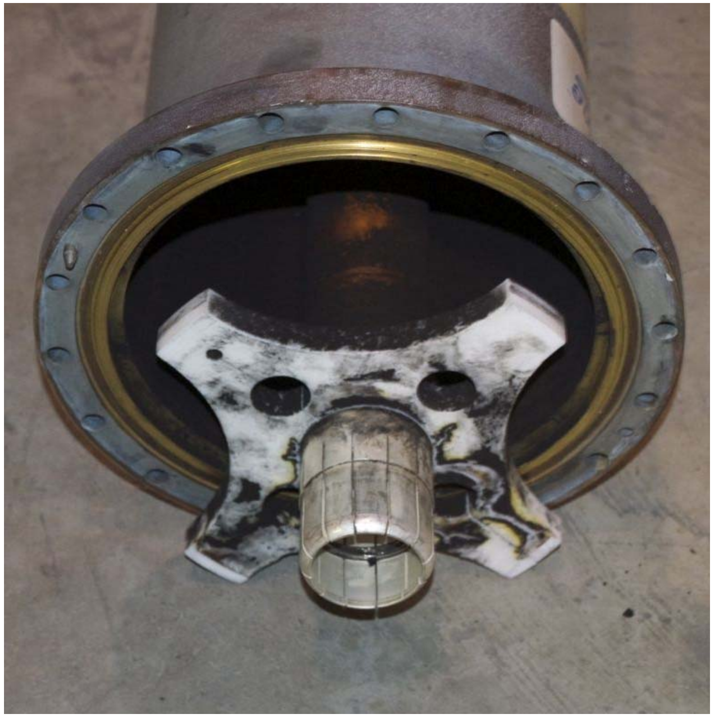
Some coax center sections had damage

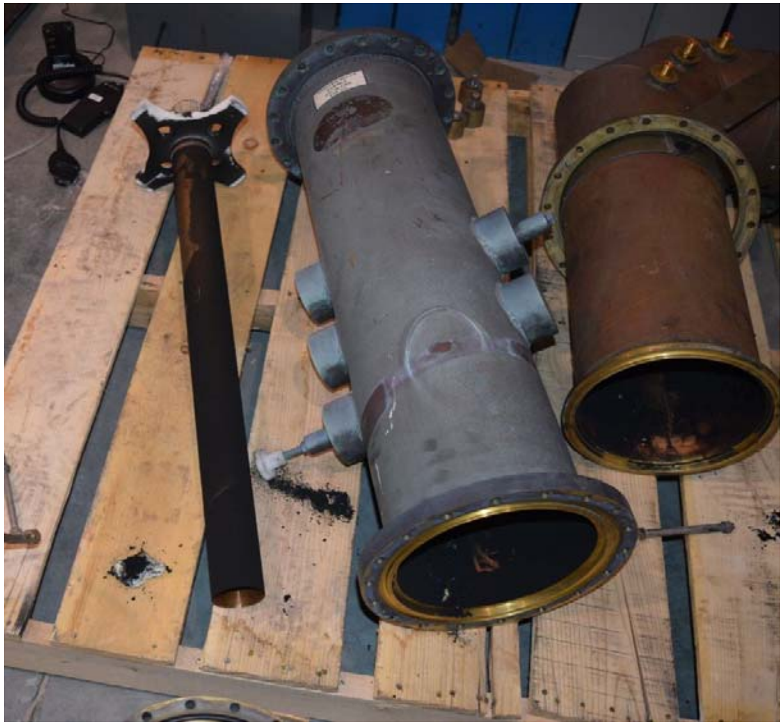




Other parts had damaged

- All damaged parts were replaced

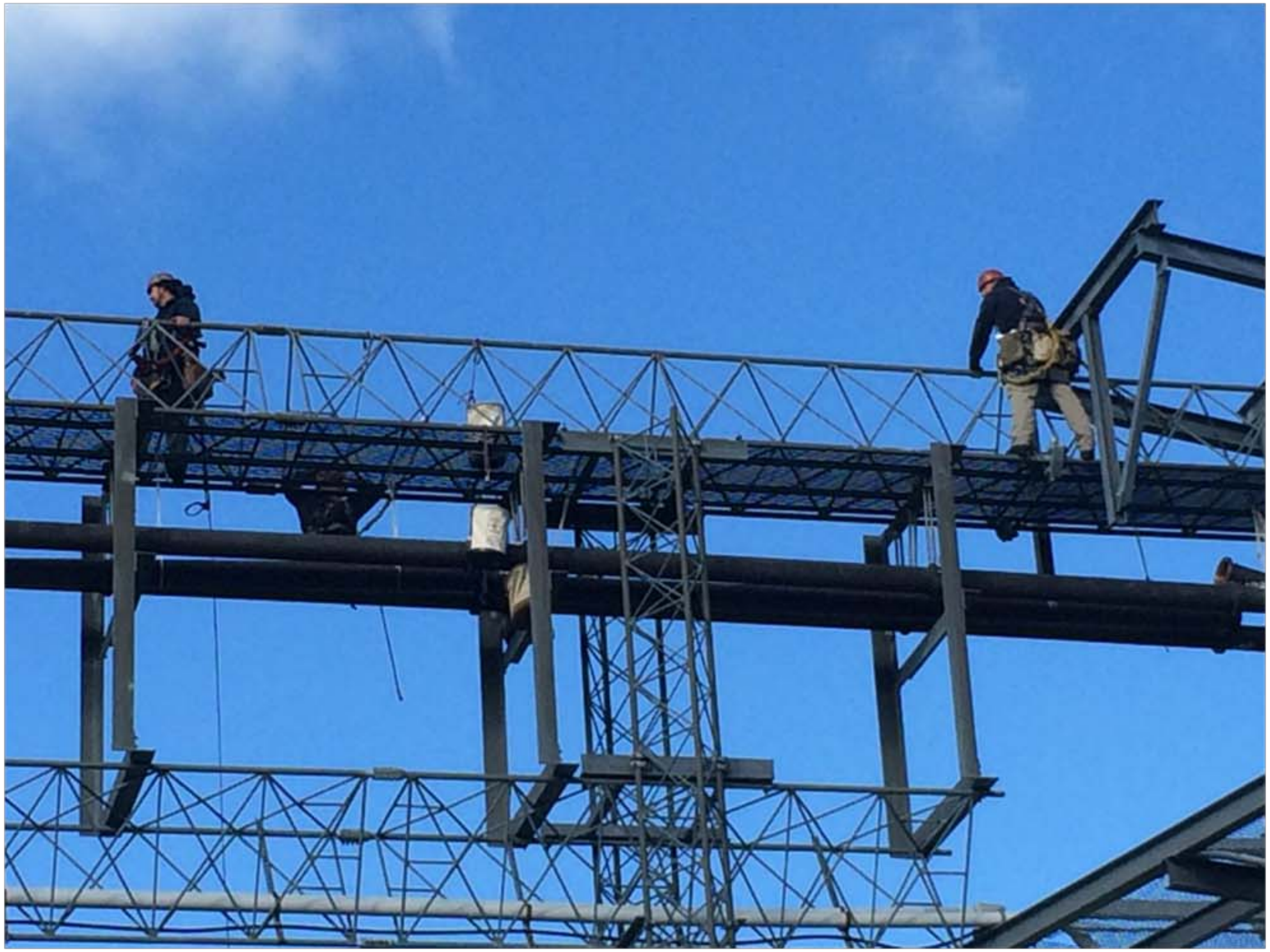




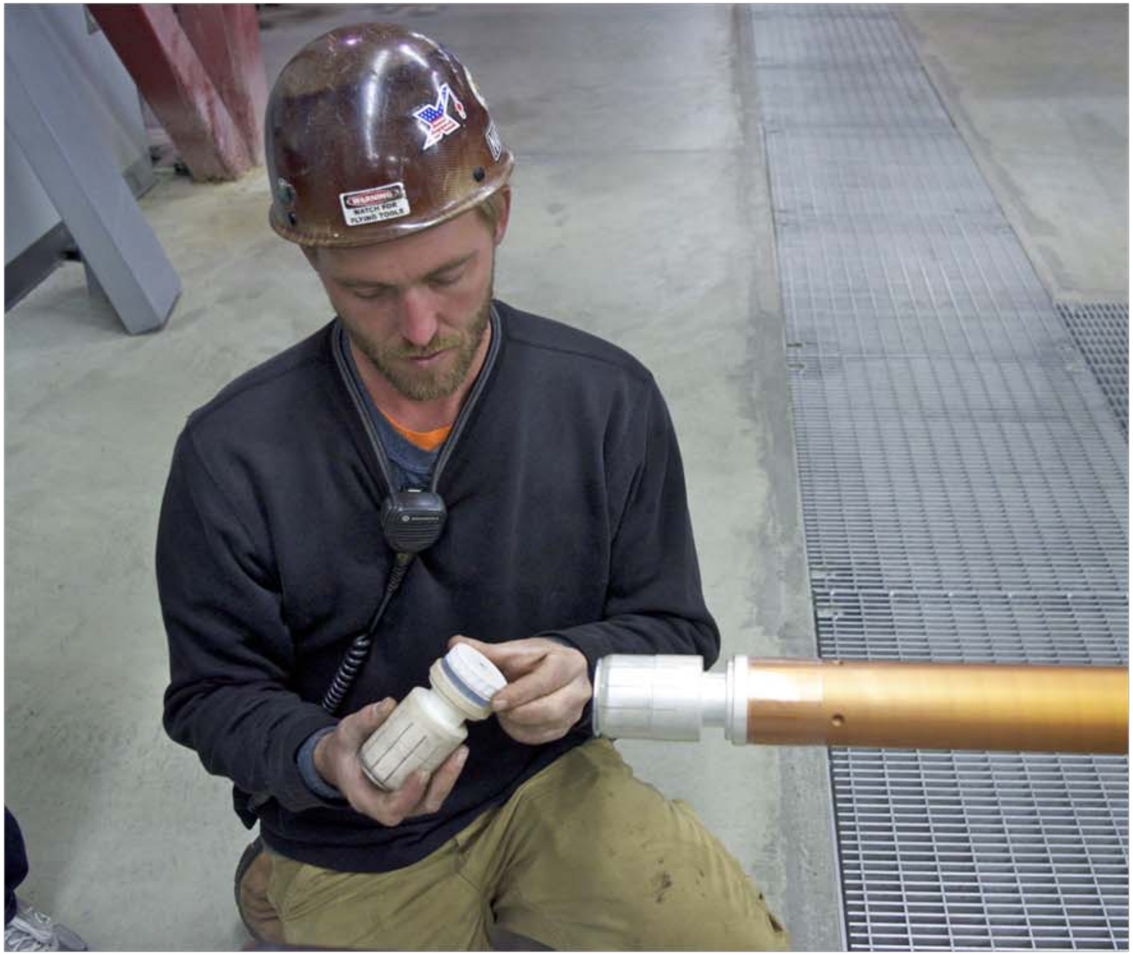
Also….

- All center insulator "bullets" and bolts were replaced for the entire run. Parts cleaned with denatured alcohol…gallons worth.

The changing of bullets on the top line



Some center line was replaced



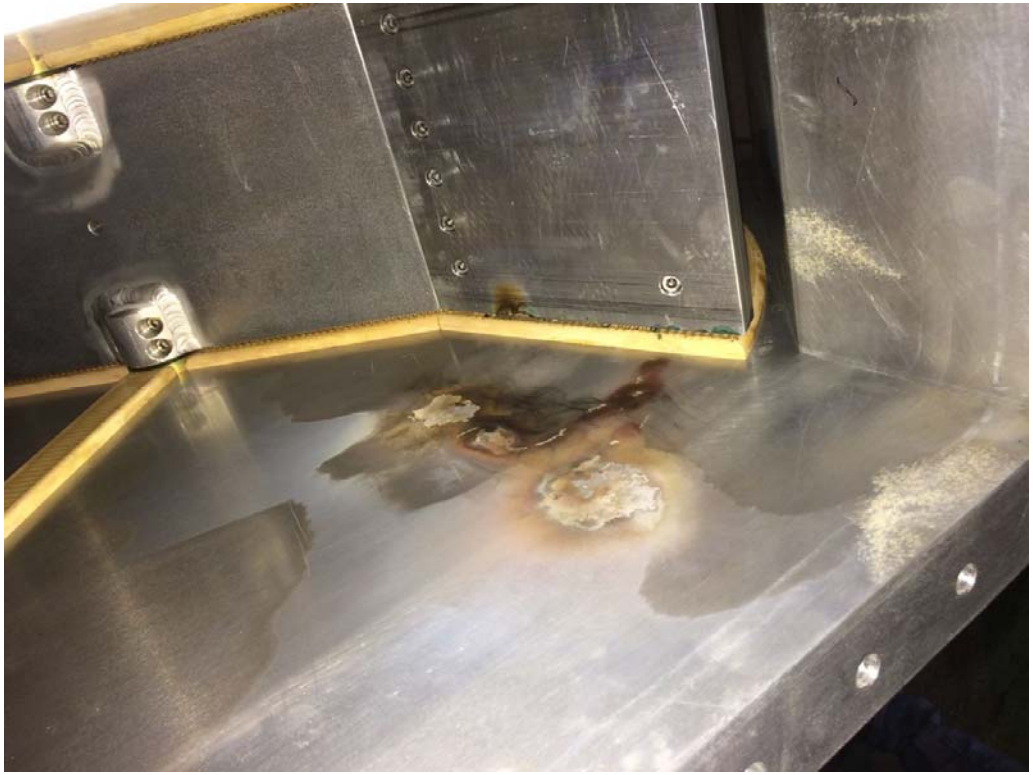
After repair, hi-pot testing was performed

Infrared camera heat check

- Was used to check for heating in the line

But more damage created

- A waveguide switch was moved while RF power was passing it. This caused arcing.



It had to be fixed!

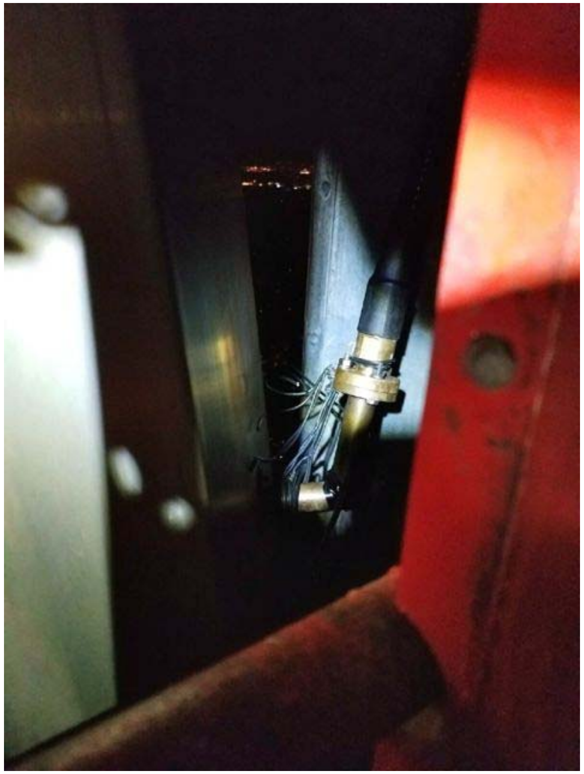
- The switch was removed and driven to Maine for repair. It came back the next day and was re-installed.

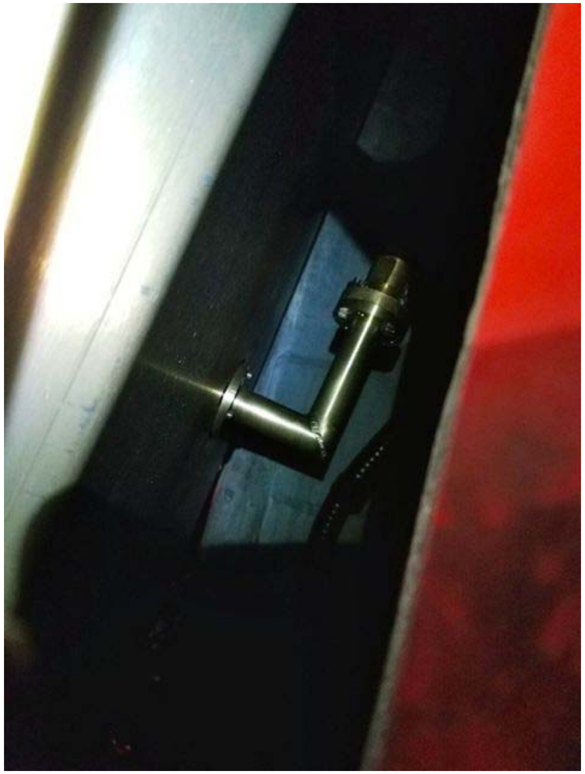
Once all this was done, the top antenna took power once again.

- Pretty much back to normal, BUT…. We had gas…
- Well, really a gas leak.

Another bad part, but in the top antenna!

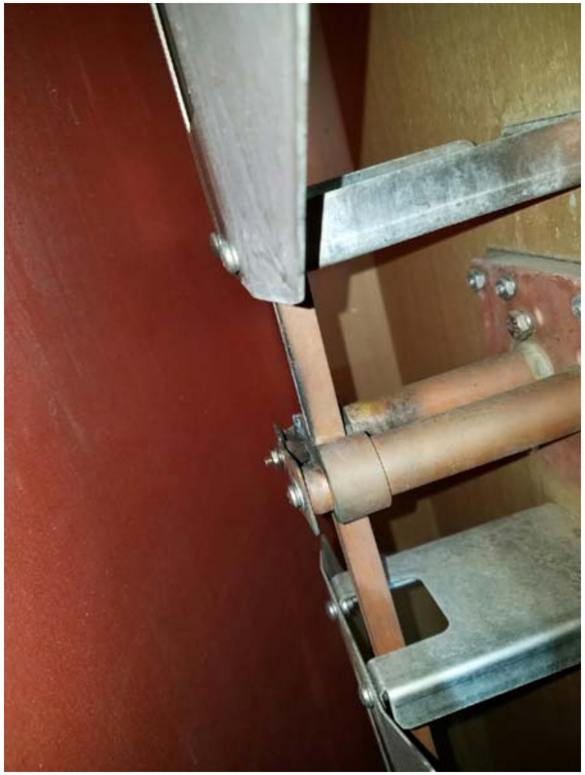
- Not related to the burn-out, but flexing.





More damage found last night

- Lightning damage to an bay element



Summary

- Almost 3 months of effort.
- Repair cost to date: about $350k.
- Most work done overnight.

That is all you need to know

- ……..About DMR radio!

- 73,
- Dan W1DAN